Remarks

Claims 1-26 are pending in this application. By this amendment, claims 2-26 have been cancelled and claims 27-72 have been added. Claims 1 and 27-72 are therefore presented to the Examiner for consideration.

Claims 6 and 8 have been rejected under 35 U.S.C. §112. Applicant has replaced claims 2-26 and in doing so has addressed the rejection raised by the Examiner. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

The claims of the subject invention have been rejected under 35 U.S.C. §103(a) over Buhl in combination with a number of references. Applicant notes the present invention combines a filtered arc source with at least one metal vapor source in a way that allows the vapour and plasma streams to mix and flow toward the substrates. This is a problematic combination, because metal vapor particles are energized differently than particles from the filtered arc source and as such the metal vapor flow is impeded by the deflecting magnetic field lines in a conventional filtered arc apparatus.

According to the invention, deflecting conductors create a deflecting magnetic field with respect to the primary plasma source(s) disposed in the cathode chamber(s), and at the same time create a focusing field with respect to the plasma vapor source(s) disposed in the plasma duct. Therefore, the deflecting conductors serve as both deflecting conductors and focusing conductors in respect to the metal vapor sources disposed in the plasma duct.

Thus, according to the invention the vapor plasma source can be positioned in a place where the magnetic force line will bring the vapor plasma to near the same area as plasma streams coming from other sources (filtered arc sources in particular). Because the vapor plasma propagates along the magnetic force lines generated by the deflecting magnetic conductor, which define plasma propagating 'corridors,' the vapor streams overlap beyond the exit of the filtered arc chamber. This works because the metal vapor sources are installed such that the evaporating area is near the plane of symmetry of the magnetic deflecting field. This effectively allows the metal vapor plasma and filtered arc plasma streams to mix, whether the vapour source is installed in a line of sight with the substrate (claim 1) or in the primary cathodic arc chamber(s) (claim 10).

Thus, an important advantage of the present invention is that it provides a way of generating a single plasma stream that mixes several metal vapor plasma flows, generated by different vapor or sputtering sources (cathodic arc, e-beam, magnetrons, thermal evaporation) to form a common, highly ionized multi-element vapor plasma flow, while still providing macroparticle-free conditions over a large area deposition zone. This is achieved according to the invention by integrating different vapor plasma sources (as a primary sources) in a plasma guide system that uses deflecting conductors to deflect vapor plasma, without impeding the flow of metal vapor.

There are several advantages to this: first, the productivity of conventional cathodic arc sources that evaporate materials from cathodic arc spots is small compared to e-beam or unbalanced magnetron sources for evaporation of refractory materials (typically materials having low melting temperature and high vapor pressure, such as Zn, In, MnO_2), and thermal evaporation for some materials having low evaporation temperature (typically materials having low melting temperature and high vapor pressure, such as Zn, In, MnO_2) has a much higher evaporation rate. By extracting metal ions from some of these sources and merging the ion flows with an evaporation flow generated by different sources, the ionization rate can be dramatically increased while maintaining a highly productive evaporation rate. This in turn results in a highly productive deposition rate without sacrificing the high quality of the coatings (high density, no voids, porosity, fine grain structure), due to intensive metal ion bombardment during the coating deposition process. In addition, only conductive materials can be evaporated by a cathodic arc; therefore, combining a filtered arc with, for example, an e-beam evaporator allows the apparatus to evaporate non-conductive ceramic like alumina, and mix the alumina vapor with 100% ionized aluminum plasma generated by a filtered arc source with an Al cathode target. This also provides a high ionization of the oxygen as a reactive gaseous plasma atmosphere, resulting in an ultra-fine alumina coating with improved adhesion which can be deposited at a reduced substrate temperature (thanks to the high intensity of metal ion bombardment during coating deposition process).

Claims 1, 3, 5, 10, 11, 17 and 22-26 have been rejected under 35 U.S.C. §103(a) over Buhl in view of Gorokhovsky. Buhl is limited to using two cathodes installed in the opposite

chambers, or one metal cathode target for generation a metal plasma and another metal cathode target as a hollow cathode to perform a plasma etching (or plasma cleaning) operations using argon as a plasma creating gas. Buhl does not teach or suggest any means of providing any other type of metal vapor source operating together with a conventional cathodic arc source. With respect, the Examiner has mischaracterized Buhl's hollow cathode gaseous source as a metal vapor source. In Buhl there is no combination of primary cathodic arc evaporation sources with other primary metal evaporation sources of other types (such as e-beam sources, magnetron sputtering sources or thermal evaporation sources) as in the present invention, which teaches merging two or more plasma flows, some filtered, some non-filtered to form a single stream composed of a multiple plasma types generated by different types of primary metal vapor sources: cathodic arc, e-beam, magnetron etc. There is nothing like this taught or suggested by Buhl, who merely incorporates a hollow cathode into a cathodic arc target to perform gaseous plasma etching operations. Buhl when viewed in combination with Gorokhovsky likewise do not suggest or describe the claimed apparatus. Applicant therefore respectfully requests reconsideration and withdrawal of the rejection based on these references.

The combination of filtered arc plasma sources with conventional evaporation sources (such as thermal evaporators) in the present invention also provides a way to ionize the metal vapor generated by thermal evaporation. In this case the hollow cathode or a conventional cold consumable vacuum arc cathode can be used as a source of electrons (electron emitter) while the thermal evaporator can be connected to the positive pole and serve as an anode. In this case the metal vapor generated by conventional thermal evaporation source will be ionized (described in the present application as resistive evaporation hot anode or 'REHA').

The cited secondary references do not teach a way of combining several metal vapor plasma flows, generated by different vapor or sputtering sources, into a single plasma stream. For example, claims 2, 6, 7, 8, 9, 12, 14 and 15 have been rejected under 35 U.S.C. §103(a) over Buhl in view of Gorokhovsky and further in view of Ehrich. Ehrich provides a hybrid process using cathodic arc as a source of electrons for ionization of a metal vapor flow generated by thermal evaporation source, but there is no way in Ehrich's design to generate a common stream formed by mixing cathodic arc vapor plasma with the ionized thermal evaporation metal flow. If

the wall **10** (see Fig.1 in Ehrich) is opened, it will result in deposition of the directly evaporated cathodic arc plasma (line of sight) which carries a huge amount of macroparticles, which is why Ehrich does not even discuss opening the wall **10** for deposition of the metal vapor plasma generated by his cathodic arc source **3**. In the present invention the primary cathodic arc source can be used both as an electron emitter and as a filtered arc deposition source depending upon the deflecting magnetic field ON/OFF mode, and it will not spoil the coating with macroparticles. The rejected claims have been replaced, however the applicant submits these references when viewed in combination do not suggest or describe the subject apparatus and method. Reconsideration and withdrawal of the rejection based on these references is respectfully requested.

Claims 19 and 20 have been rejected under 35 U.S.C. §103(a) over Buhl in view of Gorokhovsky and further in view of Giersch *et al.* Giersch, *et al.* use a laser-ignited vacuum arc source for coating deposition on large substrates. In Giersch, *et al.* there is no means for deflecting the laser-arc vapor plasma flow, his is purely a line-of-sight process. Therefore, all droplets and macroparticles generated by laser-arc evaporation are entrained in the vapor metal plasma and move toward substrates to be coated. This is a drawback which is eliminated by the present invention, by installing the laser arc targets as primary vapor plasma sources in the plasma guide of the filtered vapor plasma source. Applicant therefore respectfully request reconsideration and withdrawal of the rejection.

Claim 21 has been rejected under 35 U.S.C. §103(a) over Buhl in view of Gorokhovsky and further in view of Klepper *et al.* Klepper *et al.* use a heated target as a cathode for cathodic arc evaporation of the materials which have a low conductivity at ambient temperatures such as Si, or B. The disadvantage to this approach is that such evaporation provides enormous amount of macroparticles, so he requires shields to reduce the density of coating defects due to macroparticles. This approach cannot completely eliminate macroparticles and further reduces the productivity of the cathodic arc process, because most of the metal plasma is captured at the shield along with the droplets/macroparticles. Another disadvantage of Klepper's approach is that heated semiconductors such as Si or boron create enormous amounts of droplets effectively reducing the target utilization rate and coating deposition rate, which is small (compare to e-

beam or magnetron sputtering sources) anyway. The present invention provides a high yield of metal vapor plasma by effectively suppressing diffusion losses of metal vapor plasma confined in the curvilinear deflecting and focusing magnetic fields, while near 100% of macroparticles are captured at the baffles strategically installed at the walls of plasma guide chamber. In fact, deposition of cubic Boron Nitride coatings using a hybrid filtered arc-E-beam evaporation process, described in the present invention (Example 14) teaches that merging the E-beam vapor flow of boron with BCN plasma flows generated by filtered cathodic arc sources allows deposition of dense and highly adhesive BN coatings with high concentration of cubic phase without a need of cathodic arc evaporation of heated boron target as proposed by Klepper. Klepper *et al.* and the cited references do not suggest or describe the subject invention. Reconsideration and withdrawal of the rejection based on these references is therefore respectfully requested.

The main apparatus claims recite separate pairs of deflecting conductors and deflecting-focusing conductors, and the method claim recites generating a deflecting magnetic field for deflecting a flow of the plasma toward the substrate holder, which features are not taught or suggested by any of the prior art. The applicant accordingly submits that the claims are allowable over Buhl, both alone and in combination with the cited secondary references.

Claims 1-26 have been rejected under the judically created doctrine of obviousness-type double patenting as being unpatentable over parent 6,663,755 in view of Buhl, Gorokhovsky, Ehrich, Giersch *et al.* and Klepper *et al.* As noted above, the previous combination of references cited do not suggest or describe the subject invention. Applicant submits that this defect is not cured when the references are examined in view of the present application's parent. The subject application describes a unique combination of pairs of deflecting conductors and deflecting-focusing conductors which generate a deflecting magnetic field. Applicant therefore respectfully request reconsideration and withdrawal fo the rejection and allowance of the appended claims.

Claims 1-26 have been provisionally rejected under the judically created doctrine of obviousness-type double patenting as being unpatentable over co-pending Application Serial No. 10/713,529 in view of Buhl, Gorokhovsky, Ehrich, Giersch *et al.* and Klepper *et al.* The cited co-pending application is a continuation of the parent 6,663,755. Therefore, applicant likewise

avers that this application viewed in combination with the cited references does not suggest the claimed invention. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

In view of the foregoing remarks and amendments to the claims, the applicant believes that the claims are now in condition for allowance and such action is respectfully requested.

Applicant invites the Examiner to call the undersigned if clarification is needed on any of this response, or if the Examiner believes a telephone interview would expedite the prosecution of the subject application to completion.

Respectfully submitted,

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